РАДАР «ГРОЗА»

инструкция по эксплуатации

ЧАСТЬ 2

ТЕХНИЧЕСКОЕ ОБСЛУЖИВАНИЕ В ПОЛЁТЕ

(на омериканском языке)

1971

RADAR "GROZA"

Operating Instructions

PART 2

IN-FLIGHT MAINTENANCE

V/O "AVIAEXPORT"
USSR MOSCOW

Page	Line	It has been printed		It should be read	
5	Table 1	200	300	230	350
	columns	130	200	160	250
	2, 3, 4	100		80	
13	3	140		110	
		...of the radar indicator picture when operating...		...of the radar indicator picture (on TU-144 aircraft) when operating...	

2. The second (auxiliary) indicator (refer to page 12 Fig. 2) is used in aicrafts of type IL-62, AN-24.
3. Because of misprint in Fig. 2 on page 12 the new one is represented below.

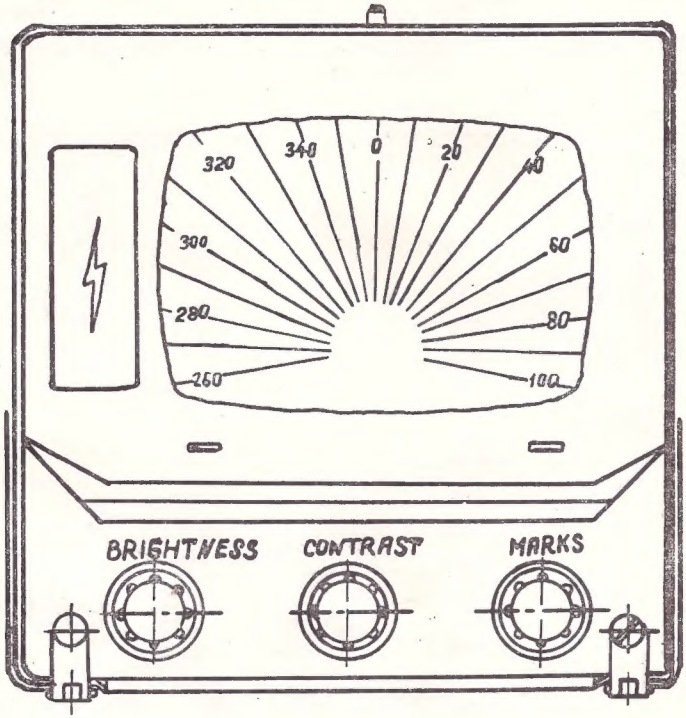


Fig. 2. Second (auxiliary) indicator front panel

SUPPLEMENTARY SHEET

for Operating Instructions of "GROZA" radar. Part 2

ATTENTION!

In "Groza" product No. 0293 some change has been made in its AFC channel circuit to assure an automatic capture that was not attained with the aid of manual control "Frequency" knob available.
In this connexion, while the radar is switched on after turning its function switch from "Standby" position to any one of "Ground", "Meteo", "Contour", "Drift" the capture proceeds automatically in 20 thru 30 seconds. But the "Frequency" knob stayed at its place providing interchangeability with transceiver units where this correction was not performed. The "Frequency" knob rotation has no influence on the radar operation.

1. Because of misprint in Fig. 1 on page 7 the new one is represented below.

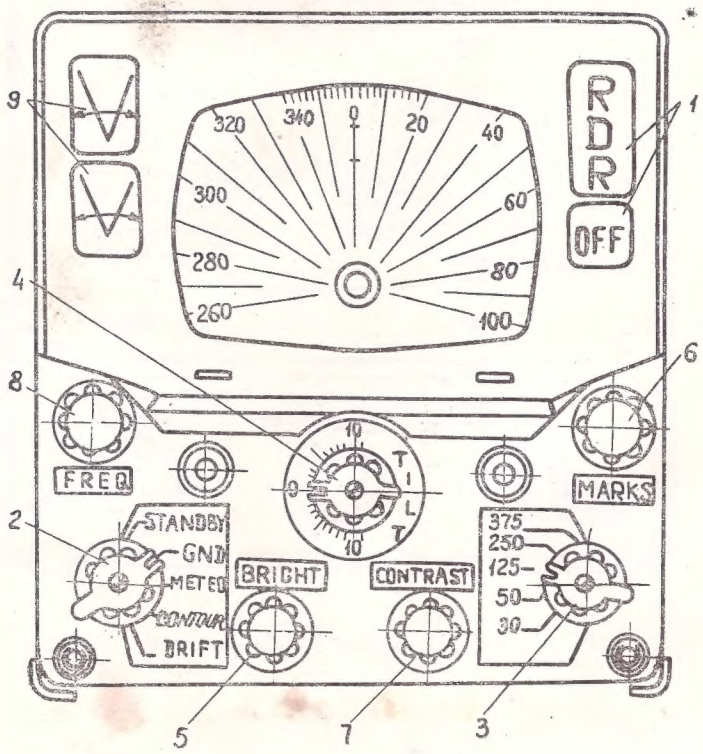


Fig. 1a. Main indicator front panel

ALTERATION RECORD LIST

Alteration Item No.	Date of Alteration Made	Basis for Alteration to Be Made	Signed
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			

This manual intended for flying and navigating personnel of civil aviation presents all data necessary and adequate for full and proper in-flight operation and maintenance of the "Groza" radar.

When starting to become familiar with it, bear in mind that the radar is an effective means for the increase of navigational accuracy and flying safety. However, its potentialities are more varied than those described in these Instructions. To completely use the radar potentialities, the crew should improve continuously their knowledge of the radar, gaining experience in operating the equipment in various situations.

The designers and makers of the radar would highly appreciate your opinion of these Instructions. Send your suggestions as to the scope, contents and design of the manual to: "Aviaexport", Smolenskaja Square, Moscow, G-200, USSR.

LOTS OF LUCKY FLYING TO YOU!

Chapter 1. PURPOSE AND BASIC SPECIFICATIONS OF THE RADAR

The "Groza" meteo-navigation radar enables the aircraft crew to:

— scan parts of earth surface ahead of the aircraft for orientation purposes using prominent landmarks. In this case the radar indicator picture approximates the representation of a particular site on the terrain map made to scale;

— detect and fix active storm zones and turbulence clouds with respect to the aircraft. In this case the radar indicator picture corresponds to the view of a horizontal air space layer ahead of the aircraft at the flight altitude;

— judge the relative hazard of the zone or cloud detected for the flight;

— measure the aircraft drift angle when flying over any stretches of land including those devoid of prominent landmarks;

— correct the aircraft present position data determined by the airborne navigational computer, should the radar be furnished with a special unit, making use of prominent landmarks to this end.

The radar operating range is governed by the version of its delivery set and the nature of objects to be scanned (Table 1).

Table 1

MAXIMUM SCANNING RANGE FOR VARIOUS OBJECTS

Objects to be scanned	Scanning range, low limit (km) for radar with		
	560 mm dia antenna on YaK-40	760 mm dia antenna on IL-62, TU-134A, TU-154 and AN-24	antenna located under fuselage of TU-124, TU-134
Very large cities and industrial centres	200	300	250
Regional and medium industrial centres	130	200	170
Vacant ground sites, large basins and rivers when operating at "250" sweep (data can be different at other sweeps)	100	150	110
Medium intensity storm zones	140	200	140

For air space or earth surface scanning at various scales of radar image, the "Groza" radar incorporates five range sweeps of different duration, that is,

— "30" sweep extending from 0 to 30 km, with range markers at 10 km intervals;

— "50" sweep extending from 0 to 50 km, with range markers at 10 km intervals;

— "125" sweep extending from 0 to 125 km, with range markers at 25 km intervals;

— "250" sweep extending from 0 to 250 km, with range markers at 50 km intervals;

— "375" sweep extending from 200 to 350—400 km, with range markers at 50 km intervals. The maximum range at which the radar indicator picture sweep is accomplished in the latter case is governed by the aircraft power supply frequency equal to 115 V, that is,

350 km for 420 Hz power supply frequency;
375 km for 400 Hz power supply frequency;
400 km for 380 Hz power supply frequency
as well as all frequencies below.

The accuracy of intervals between any two adjacent range markers is not less than:

±2% of the interval at the crew cabin temperatures within 0 to +35° C;

±5% of the interval at the crew cabin temperatures from −40 to +50° C.

The azimuth scanning sector of the "Groza" radar is not less than 100° on both sides of the aircraft structural axis. The indicator azimuth scale is spaced at 10° and numbered at 20° intervals. The azimuth sector of ±20° with respect to the zero mark has additional calibration at 2° intervals for measuring the aircraft drift angle.

For higher stability of the ground surface radar picture and minimum distortion of the storm zone picture when manoeuvring, the "Groza" radar features gyroscopic stabilization of the antenna beam operable up to the banking within 15°.

Several different versions of the "Groza" radar are made and mounted on board, that is, those comprising:

— one indicator and one transceiver,

— two indicators and one transceiver,

— one indicator and two transceivers (high reliability),

— two indicators and two transceivers (high reliability),

— an additional unit for correction of navigational computers using prominent radar check points.

The purpose, performance and operating principles of all versions are the same, minor differences in their design and additional control procedures being described in detail below.

Chapter 2. RADAR CONTROLS

1. CONTROLS PROVIDED IN THE RADAR INCORPORATING ONE INDICATOR AND ONE TRANSCEIVER

The "Groza" radar is so designed that most of its controls and operating knobs are located on the front panel of the indicator (indicators), but one switch "Резерв. стаб." ("Reserve stab.") being built in one of the cabin instrument boards. This switch makes it possible to disconnect the radar antenna gyro stabilization

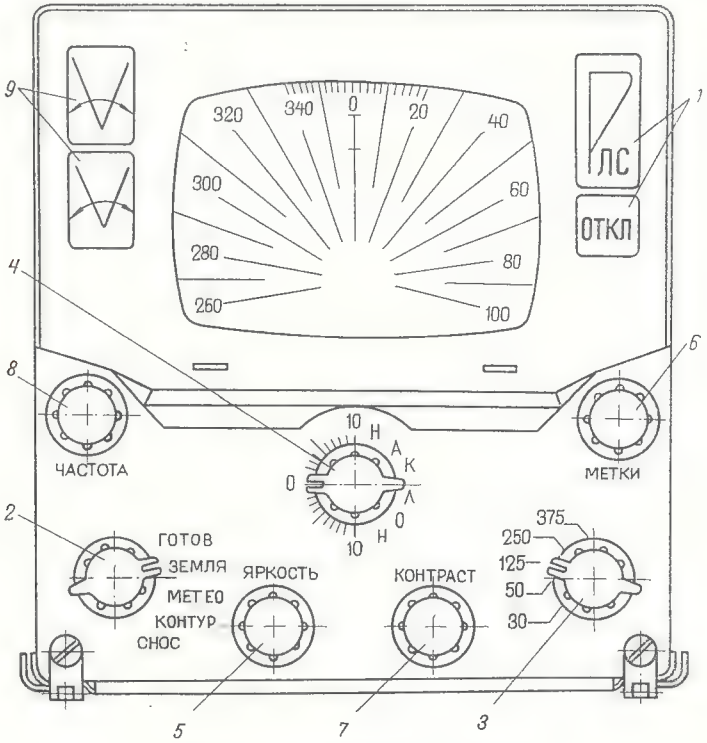


Fig. 1. Main indicator front panel

system if the aircraft gyro vertical fails. In this case the antenna operates without gyro stabilization, the azimuth swinging plane of its reflector coinciding with the aircraft longitudinal horizontal plane.

The radar main indicator front panel with its controls *1—9* is presented in Fig. 1.

The purpose of each control

1 — Radar On — Off Keys. Marking: "РЛС" ("RDR"), "Выкл." ("OFF").

To connect the radar to or disconnect it from the airborne power supply, press the key required. In so doing, normal operation of the radar starts in 3 or 5 minutes after it is cut in, when its units and components are warmed up. This delay is set up automatically.

With the radar disconnected from the airborne electric power supply, even not for long, and switched on once more, the same delay occurs.

2 — Function Switch. Positions: "Готов" ("Standby"), "Земля" ("Ground"), "Метео" ("Meteo"), "Контур" ("Contour"), "Снос" ("Drift").

This is the main switch governing the operating conditions of the radar.

When the switch is put to the "Готов" position, radio waves are not radiated, but the radar is ready for immediate operation provided it has been connected to the aircraft power supply mains through pressing the "РЛС" key not less than 5 minutes in advance.

With the function switch put to the "Земля" position, radiation of radio waves begins and scanning of earth surface located within the radar azimuth scanning zone occurs. As this takes place, the "Контраст" *7* control located on the front panel becomes operative. This control makes it possible to increase image contrast of the earth objects (such as cities, rivers and basins) of interest for the operator against background echoes from vacant ground sites. The radar is so designed that no readjustment is necessary to retain quality of the radar indicator picture as the aircraft flight altitude or the nature of a ground site being scanned vary. These variations are compensated for in the radar automatically.

In the "Метео" mode the radar radiates radio waves as a narrow beam and scans an air space layer limited in altitude, picking up no earth surface. This enables to observe radar indicator images of thick cumulus clouds and storm zones without interference from earth surface at any flight altitudes above 1000 m.

When the switch is turned over to the "Контур" position, the radar, as in the preceding mode, detects meteo formations, but special switcing results in complete suppresion of detected storm zones and thick clouds (on the indicator) whose echo intensity exceeds a predetermined value. This enables the crew to judge indirectly on the turbulence to be expected in the detected zone (or cloud).

In the "Снос" position the radar starts earth surface scanning again, but automatic azimuth motion of its antenna is cut out. To

match the beam projection onto the earth surface with the aircraft true track line necessary for measuring the aircraft drift angle, shift the antenna in azimuth manually, making use of the " ⋋ " key. For adjustment of the antenna travel speed, use the "Контраст" control.

3 — Sweep Duration Switch. Positions: "30", "50", "125", "250", "375".

This switch is intended to vary the duration of sweep and thus of the radar indicator picture scale. When turned over to the first four positions, the sweep begins with zero range and ends at the instant echo radio waves come from the distances marked. In the last (fifth) position the sweep begins from the 200 km range and ends at the instant signals from 350—400 km reach the radar. With this sweep on, part of the space from zero range to distances up to 200 km is not scanned on the indicator, all signals from the objects located at 200 km from the aircraft being concentrated in one point which is the sweep origin.

4 — Antenna Beam Tilt Control. Marking: "Наклон" ("Tilt").

This control makes it possible to tilt the radar antenna beam up or down with respect to the horizon plane through any angle up to 10°.

Calibration of the control scale corresponds to a space position of a narrow beam in the "Метео" or "Контур" modes. When operating in the "Земля" or "Снос" modes, the angle value read off from the scale does not correspond to the true value of tilt, but the crew do not need to know the beam position in space exactly in such cases, because the criterion for its optimum shift consists in a clear picture at a maximum range free from dead spots. For approximate orientation of the beam in vertical plane in these modes use is made of the same angle scale as in the "Метео" and "Контур" modes.

5 — Radar Picture Brightness Control. Marking: "Яркость" ("Brightness").

Intensity of exterior light incident upon the aircraft radar indicator screen may vary over wide limits which makes it necessary to vary the brightness of the whole radar picture respectively. For this purpose, the picture brightness control is provided. The "Groza" radar circuit is so designed that, when adjusting the radar picture brightness, a simultaneous and proportional variation in brightness of range markers and an optimum position of the "Контраст" control selected by the operator occurs.

6 — Range Marker Brightness Control. Marking: "Метки" ("Markers").

This control is intended for individual adjustment of brightness of range markers with respect to the rest of the radar picture.

7 — Contrast Control for Pictures of Surface Objects of Interest for the Operator. Marking: "Контраст" ("Contrast").

With the radar operating in the "Земля" mode, this control enables to increase contrast of such objects as large localities, rivers and basins or individual groups of structures when flying close by an airport against the general terrain background noise. The radar picture of a vacant site usually consists of a number of small luminant spots varying in their brightness due to the different ability of various parts of the site (e. g. sand, arable land, meadow, forest, etc.) for reflection of radio waves. Specifically, this fact results in the deterioration of radar pictures of water objects, making a picture blurred and partly masked. In addition to that, small localities, accidents of the ground and individual structures with good reflection power that the crew are not able to identify produce a lot of sufficiently bright flare spots distracting attention and making it more difficult for the crew to read the picture. The "Контраст" control enables to eliminate in the radar picture partially or completely the signals from such unidentifiable objects as well as equalize brightness of vacant site pictures. With the control turned until rest, the indicator picture will comprise a uniformly bright background corresponding to reflections from vacant ground sites against which only particularly large localities are seen as flare spots differing abruptly in their brightness and water reference points — in the form of sharply defined dark spots or lines.

Besides, when operating in the "Снос" mode, the "Контраст" control makes it possible to vary speed of the antenna motion in azimuth, the possibility of contrast increase unacceptable for this mode being ruled out.

8 — Heterodyne Frequency Control. Marking: "Частота" ("Frequency").

This control enabling to adjust the radar local heterodyne frequency is used to introduce frequency into the holding zone of the automatic control system after switching the radar on. Further adjustment is effected by the aforesaid system automatically.

9 — Antenna Azimuth Shift Manual Control Keys. Marking: "⋈".

These keys make it possible to start azimuth shifting of the antenna in any direction required for drift angle measurements as well as stop it at any instant.

The controls and switches *2*, *3*, *4*, *5*, *7*, *9* are operational, that is, used most frequently during the flight. By contrast, controls *1*, *6* and *8* are intended for additional adjustments and used once or

twice during the whole flight. Location of the switches and controls on the main indicator front panel complies with the frequency of their usage.

2. CONTROLS PROVIDED IN THE RADAR INCORPORATING TWO INDICATORS

With the radar supplied complete with an additional (second) indicator unit, its operation comprising: connection of the radar to the aircraft power supply mains; switching on the mode of operation required; switching on the sweep duration (radar picture scale) required; tilting the antenna beam at a predetermined (optimum) angle with respect to the horizon plane; controlling the antenna when measuring the aircraft drift angle is controlled from the main indicator whose controls (their purpose and grouping) are described above in Section 1 of Chapter 2.

The second indicator supplied within this delivery set features the controls enabling individual adjustment of the radar picture quality and its range markers, that is, the "Яркость", "Контраст", "Метки" controls.

The purpose, operating principle and marking of these controls are similar to those of the main indicator described above. To let the pilot know on what sweep the radar operates at a given instant of time, the decorative mask of the second indicator screen features an illuminated diagram indicating the intervals at which the range rings visible on it are spaced.

An external view of the additional (second) indicator front panel with its controls is shown in Fig. 2.

3. CONTROLS PROVIDED IN THE RADAR INCORPORATING TWO TRANSCEIVERS

When erecting on board plane the "Groza" radar equipment comprising two transceivers, the "Резерв. перед" ("Reserve transcr.") switch mounted on an instrument board in the crew cabin is provided in addition to the above keys, switches and controls located on the main and additional (if any) indicators. This switch is intended for cutting in the second (reserve) transceiver instead of the main one, should the latter become faulty. From the instant the radar is connected to the aircraft power supply mains the standby transceiver is kept hot and thus starts operating as soon as the switch is changed over.

There are no other differences between the sets comprising one and two transceivers.

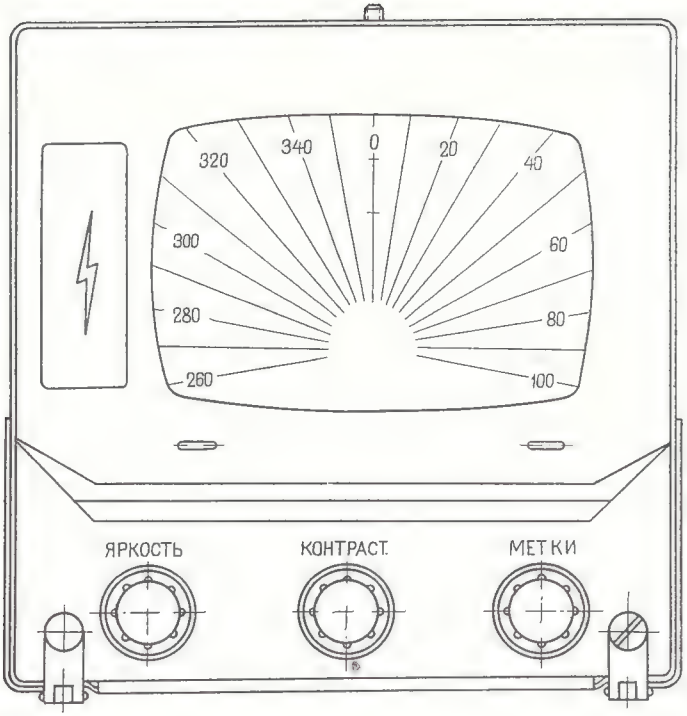


Fig. 2. Second (auxiliary) indicator front panel

Chapter 3. OPERATING THE RADAR

For in-flight maintenance of the "Groza" radar equipment on board any type aircraft, be sure to remember and comply with the following general requirements, instructions and practices.

When the radar is not in use, change the function switch over to the "Готов" position, thus reducing a probability of the radar failure during the flight and extending its total service life.

With the plane in the air, do not operate the "Откл." key of the main indicator till the flight is completed, otherwise the radar will be cut out for some 3 or 5 minutes at the very time it is required.

Having obtained a picture on the radar indicator using the "Частота" control, do not operate it any more. Should the picture disappear, restore it by means of the aforesaid control, complying strictly with the requirements set forth in Section 7 and checking all other switches and controls of the radar for their proper settings beforehand.

Bear in mind that when operating in any mode the "Groza" radar does not detect any turbulence related to formation, existence or development of clouds in free atmosphere.

When operating at the "375" sweep, remember it begins with the 200 km range, the whole zone from the aircraft up to this range being not scanned by the radar.

Avoid operating at the "375" sweep, when flying through storm or active vertical cloud formation zones regardless of the radar mode of operation. Should the radar incorporate two indicators, be sure to warn the pilot on switching this sweep on.

If you suspect a decrease in the scanning ranges for earth surface or other objects, as compared to those observed before, switch on the "Готов" mode, return the "Частота" control to its extreme left position, then use the latter to restore the picture in the "Земля" mode.

Remember that the power supply ON signal lights up in the "Готов" mode only and make sure there are range rings on the radar indicator screen in all other modes.

In case of +27 V circuit temporarily cut off in any of the modes specified for the "Groza" radar, the function switch should be changed over to the "Готов" position with subsequent return to the position required to restore normal radar operation.

4. SAFETY PRECAUTIONS TO BE TAKEN WHEN OPERATING THE RADAR

The "Groza" radar is so designed that a radiation level safe from the viewpoint of biological standards is assured both in the crew cabin and passenger compartment on any type aircraft furnished with this radar. High frequency radiation can affect only those outside close by the aircraft nose. Because of this:

Never change the mode switch from the "Готов" position over to any other position prior to taking off until the runway has been approached.

After landing, change the function switch over to the "Готов" position until the runway has been left or cut out the radar completely.

No other safety precautions are required when operating the radar both on the ground and in the air.

5. PURPOSE, MOUNTING AND STORAGE OF PROTECTING TUBE AND POLAROID FILTER

A readily detachable protecting tube with a coated polaroid filter fitted in it is intended to increase contrast of the radar indicator picture when operating in daylight. This increase is effected owing to the fact that the light filter reduces outside light

reflected by the indicator screen to a much greater extent than the light emitted by the radar cathode ray tube screen picture. In addition to that, the tube walls protect the indicator screen against straight light beams entering through the crew cabin glass.

For prolonged service life of the radar polaroid filter without the deterioration of its properties, the rules for its maintenance and storage should be complied with.

For protection of the light filter, check up the tube for a reliable connection to the indicator front panel each time before switching the radar on and keep the light filter coating safe against damage during the whole period of the radar operation.

To avoid clogging of the filter, do not touch its surfaces with hand and wipe them carefully with a piece of soft clean gauze or flannel, should greasy spots appear. When badly clogged, wipe off the filter surfaces with a wad of gauze wetted in commercial rectified alcohol. If dust or dirt is found on the light filter, remove it carefully, making sure not to scratch the filter surfaces.

Never use acetone, hydrolysis alcohol or other substitutes for cleaning the filter.

Since the polaroid light filter is a laminated structure made of acetyl cellulose film, its moisture resistance is not sufficient for areas with excessive air humidity. In this connection, when basing or landing the plane on the fields with excessive air humidity, remove the protecting tube from the radar indicator and store it in dry premises air conditioned, if possible. It is permissible to keep the tube and the light filter in position, if the aircraft will not remain on the ground in a humid area for over four hours.

Transport and store the protecting tube in a packing box. Additional precautions should be taken for protection of the box from moisture by placing it in a navigator's case or making other arrangements in case of precipitation.

6. SWITCHING ON THE RADAR ON THE GROUND

Switching on the "Groza" radar consists of three stages as follows:

— getting the radar ready for switching on (checking up the settings of the radar controls);

— cutting the electric power supply in;

— turning on radiation of radio waves into space.

This may become necessary when taking off under poor meteorological conditions and the crew must be sure in advance there are no hazardous meteo formations on the take-off and ascending path.

For switching the radar on, proceed as follows:

a) **set all switches and controls** on the main and auxiliary (second) indicators to the following positions:

— the "Частота" control of the main indicator to the extreme counter-clockwise position (left);

— the main indicator mode switch to the "Готов" position (that is, extreme counter-clockwise position);

— the "Яркость" controls of both indicators to their mid-positions;

— the "Наклон" control of the main indicator to its mid-position;

— the "Контраст" controls of both indicators to their mid-positions;

— the main indicator sweep duration switch to the position marked "125" (mid-position);

— the "Метки" controls of both indicators to their mid-positions.

The "Резерв. стаб." switch located on an instrument board in the crew cabin should be set to its bottom position ("Откл.").

If the radar equipment incorporates the second (standby) transceiver, the "Резерв. перед." switch provided on an instrument board should also be set to its bottom position;

b) **for cutting in the radar power supply,** proceed in the following way:

— turn on the aircraft gyro vertical complying with its operating instructions. Be sure to turn on the gyro vertical with which the radar is connected;

— if the radar is interconnected with the airborne navigation computer or a set of navigating and piloting equipment, switch on the appropriate computer or set complying with their operating instructions;

— turn on the radar on-off switch or network protector located on the navigating and piloting equipment panel (TU-144, TU-154 aircraft) or the airborne power supply board (YaK-40, IL-62 aircraft, etc.);

— push the "РЛС" key of the main indicator as far as it goes. Make sure that the key remains flushed after release and a light signal indicative of normal switching on of the radar lights up on the main indicator front panel (in the screen bottom). However faultless the completion of all procedures may be, radiation of radio waves into space cannot be turned on before its preheating and preparatory procedure is completed, the duration of the procedure varying from 3 to 5 minutes depending upon ambient temperature. This time delay is performed by the radar automatically;

c) **for turning on radiation** proceed as follows:

— five minutes after switching the radar on make sure that there are no large reflecting objects such as hangars, large buildings, etc. within the azimuth sector of 100° on both sides of the longitudinal axis at distances less than 100 metres from the aircraft, then change the main indicator mode switch over to the "Земля" position. **If this is not achieved, the radar may fail.** In doing so, luminant range rings should appear on the screen and the power supply on signal switch off;

— should there be no luminant rings on one or both indicators, rotate their "Метки" controls till the rings appear. If this method does not result in obtaining the range rings, operate the "Яркость" controls, having set the "Метки" controls to their extreme right-hand positions. It would be sound practice to change the sweep duration switch in this case, prior to operating the aforesaid controls, from position "125" to "375" and vice versa.

A schematic representation of the indicator screen with luminant range rings at various sweep durations is shown in Fig. 3. Both three and four range rings can be observed in this case on the "375" sweep, the fourth one being much wider and brighter than all others or consisting of two or more separate closely spaced rings in a number of cases. The range rings should approximate circles in their form and distances between neighbouring rings should be approximately the same.

Except for the "375" sweep, the last range ring at all sweeps should be located behind (above) the top horizontal line marked on the screen across the zero azimuth line. As to the "375" sweep, where the fourth ring may be lacking completely, the third one should be located behind (above) the nearest horizontal line.

There should be five range rings at the "50", "125" and "250" sweeps within the azimuth sectors of 40—50° or 320—310°, three rings at the "30" sweep and three or four at the "375" sweep;

— rotate the "Частота" control from its extreme (left) position in a clockwise direction until blips from ground features and structures within the azimuth sector scanned by the radar appear on the indicator(s).

Rotate this control smoothly and slowly at a speed of not over one revolution per 10 seconds and stop the rotation right after the blips are visible.

Thereupon, do not operate the "Частота" control during the whole period of the radar operation till cutting it out. Should the radar picture disappear, restore it using the above control, having checked beforehand all other switches and controls for their proper settings;

— if no blips are visible on the indicator after turning the "Частота" control to the right as far as it goes, change the mode switch over to the "Готов" position, return the "Частота" control

to its extreme left position, then change over to the "Земля" mode again. Repeat the procedure set forth in the preceding paragraph;

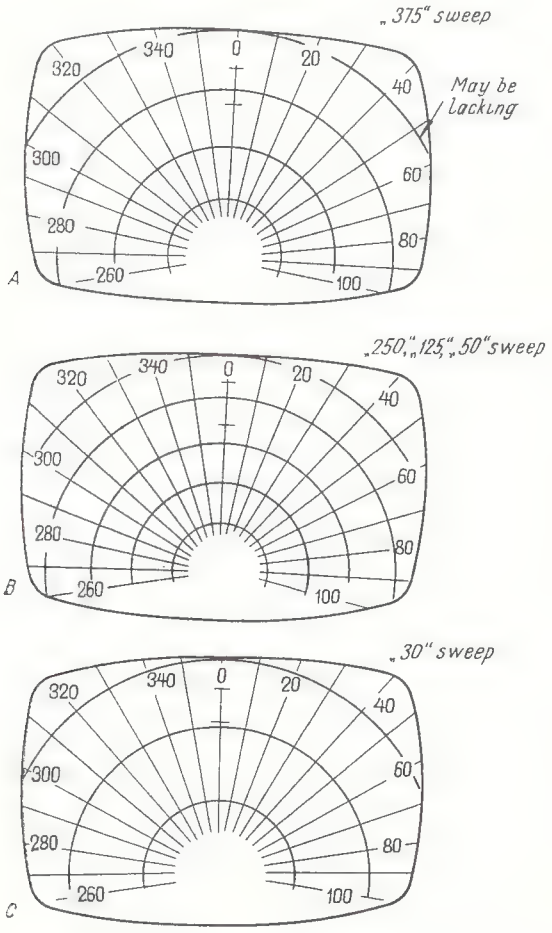


Fig. 3. View of the indicator screen at various sweep durations

— change the mode switch over to the "Грозы" position. Raising the radar beam with the aid of the "Наклон" control, proceed in this manner till no ground feature blips are visible. Then return the control to its zero position.

When the procedures set forth above are carried out, the radar is ready for service in any of its operating modes.

Fig. 4a shows the radar indicator screen with range rings and ground clutter, when switching on the radar on the ground.

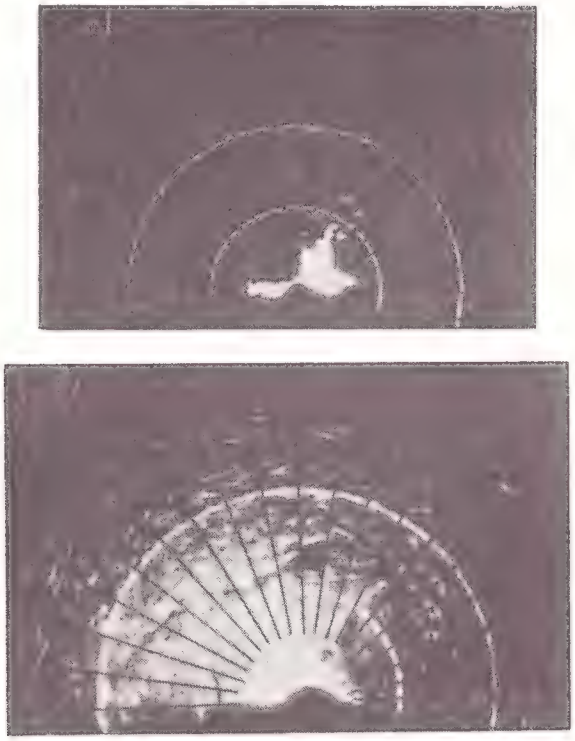


Fig. 4. Approximate shape of radar pictures:
a — when switching on the radar on the ground; *b* — when switching on the radar in flight

7. SWITCHING ON THE AIRBORNE RADAR

When switching the airborne radar on, radiation of radio waves is turned on by the crew with the aircraft in the air, but all preceding stages of the switching-on procedure can be carried out both in the air and on the ground.

For switching the airborne radar on, proceed as follows:

— check up the settings of all switches and controls on the main and auxiliary (second) indicators, making sure that they comply with those given in Item 6a of these Instructions;

— cut in the radar power supply, complying with the rules set forth in Item 6b of these Instructions;

— turn on the radar radiation, changing the main indicator mode switch over to the "Земля" position. In so doing, luminant range rings should appear on the radar indicators;

— if there are no luminant rings on one or both indicators, rotate the "Метки" controls till the rings are visible. If this method does not result in obtaining the range rings, make use of the "Яркость" controls, having set the "Метки" controls to their extreme right-hand positions. It would be sound practice to change the sweep duration switch in this case, prior to operating the aforesaid controls, from position "125" to "375" and vice versa;

— when the luminant range rings are seen, use the "Наклон" control to tilt the radar beam down through 7°;

— turn the sweep duration switch over to the following positions:

"30" at flight altitudes below 3000 metres,

"50" at flight altitudes from 3000 to 5000 metres,

"125" at flight altitudes from 5000 to 12 000 metres,

"250" at all flight altitudes above 12 000 metres;

— rotating the "Частота" control in a clockwise direction, make sure the radar picture of ground surface appears on the radar screens.

Rotate this control smoothly and slowly at a speed of not over one revolution per 10 seconds and stop the rotation right after the radar picture is visible.

The radar picture should be visible at all azimuth angles within $\pm 100°$ without dead spots and discontinuities;

— if the picture obtained is much less brighter and shorter than usual, change the mode switch over to the "Готов" position, then return the "Частота" control to its extreme left position. Reset it to the "Земля" mode and repeat the procedure described in the preceding paragraph.

When the procedures set forth above are carried out, the radar is ready for service in any of its operating modes.

Fig. 4b shows the radar picture of ground surface, as obtained when switching the airborne radar on.

8. SWITCHING THE RADAR OFF

To switch the "Groza" radar off, push the "Выкл." key of the main indicator and turn the radar on-off switch or network protector located on the navigating and piloting equipment panel (TU-144, TU-154 aircraft) or the airborne power supply board (YaK-40, IL-62 and other types of aircraft) to the "OFF" position.

Particular attention in this case should be paid to the fact that, no matter how short the period of disconnecting the radar power supply is, three to five minutes delay is required when switching it on again to let the equipment get ready for operation. No radar picture can be obtained in any mode before this time lag is up.

The "Groza" radar is an intricate radio electronic device comprising many a hundred parts and components, each component having a certain probability of failure. The transceiver components operating when radio waves are radiated by the radar are the least reliable. **Therefore, if there is no need to use the radar for a while, but it can become necessary at any instant, turn radiation out by changing the mode switch over to the "Готов" position.**

To turn radiation on in this case, no time lag is necessary because radiation starts right after the mode switch is turned over to any other position. It goes without saying that one should never push the "Откл." key, that is, cut out the radar, in such an event.

9. OPERATING THE RADAR WHEN FLYING THROUGH STORM ZONES AND CLOUDS

Radar Operating Procedure for the "Метео" Mode

When operating in this mode, the "Groza" radar enables the aircraft crew to detect active storm zones, heap rainy and thick heap clouds as well as makes it possible to fix the position of these hydrometeorological objects on an azimuth and range.

A typical radar picture for this mode is presented in Fig. 5 (*A* and *B*). As will be seen from the figures, restricted possibilities of the radar indicators do not make it possible to determine from the radar picture what areas of the zone or cloud detected show the most turbulence and their hazard for the aircraft in general. Therefore, in the "Метео" mode the radar informs the crew on hydrometeorological objects on the flight path, indicating alternate paths for bypassing these objects on an azimuth. When in good working order, the "Groza" radar detects practically all hazardous hydrometeorological objects. In certain cases it can also detect non-hazardous objects which cause excessive bumping when flying through them.

To change the radar over to the mode under consideration:

— set the mode switch to the "Метео" position;

— set the sweep duration switch to the position "250";

— shift the "Наклон" control to its zero position;

— using the "Яркость" control, set a required brightness of the range rings, avoiding, however, intensive continuous gating

of the whole area of the indicator screen. When carrying out the adjustment, set the "Метки" control to its mid-position;

— having detected a hydrometeorological object, change over the sweep duration switch as the object is approached, proceeding from a specific situation;

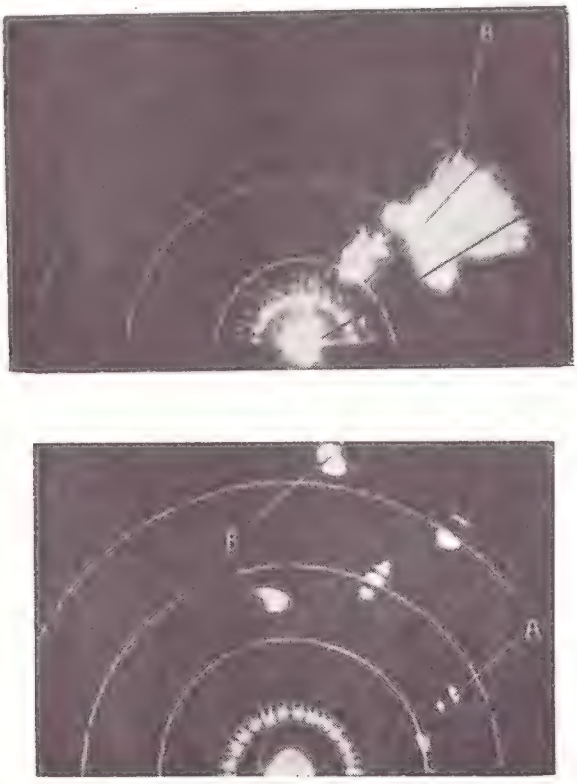


Fig. 5. Typical screen pictures for the radar operation in the "Метео" mode

— should there be no radar pictures of meteorological objects for a long time, in an instrument flight (such as when flying in clouds or at night) or in visual detection of suspensions clouds with no picture of the latter on the radar screen, check up the radar for operable condition by tilting its beam down at 6—7° with the aid of the "Наклон" control. When ground echo appears on

the screen in the form of a sufficiently wide luminant circular zone (see Fig. 6), the radar is in good working order;

— reset the "Наклон" control to zero.

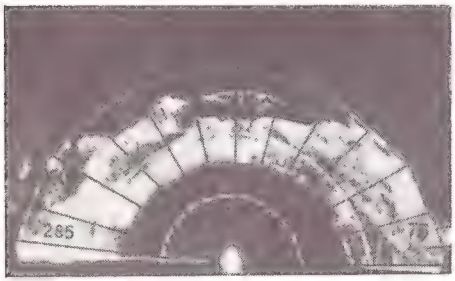


Fig. 6. Approximate shape of radar picture when checking the radar for operable condition in the "Метео" mode

The "Контраст" control provided both on the main and auxiliary (second) indicators is disconnected when operating the radar in the "Метео" mode and may be set, therefore, to any position.

Radar Operating Procedure in the "Контур" Mode

Since information alone on a hydrometeorological object within the scanning zone is often insufficient and the crew may want to know the extent of danger it presents, the "Groza" radar incorporates a special mode of operation enabling such an estimate to be made.

From the viewpoint currently held, the degree of turbulence in clouds is proportional to the precipitation rate from them. However, contemporary airborne radars incapable of measuring this speed directly measure turbulence in an indirect way from the differences of precipitation intensities from adjacent parts of a cloud (precipitation gradient).

When operating in the "Контур" mode, a radar picture enabling to draw a conclusion on the precipitation gradient and thus make a rough estimate of the degree of turbulence is obtained. Reflected in this mode from turbulent clouds and storms, the radio waves exceeding in their intensity a specific value result in no picture on the indicator screen, the portions of the image of a hydrometeorological object that correspond to them becoming dark. The reflected waves whose intensity is below the specific value, but sufficient to result in the radar image yet continue to gate the screen.

A typical image of storm zones with the radar operating in the mode mentioned above is presented in Fig. 7.

Be sure to change over the "Groza" radar from the "Метео" mode to the "Контур" mode on having detected an image of a hydrometeorological object on the radar indicator. The purpose of this is to estimate turbulence and thus the extent of hazard from the object detected or choose the least hazardous path for passing through it. In so doing, the radar operating procedure is as follows:

— change the mode switch over to the "Контур" position;

— adjust the picture brightness, if necessary, using the "Яркость" control.

When the procedures set forth above are performed, the images of the objects whose echo intensities are over the specific value appear on the screen in the form of light spots alternating with dark ones which will serve as a warning for the crew about an appreciable probability of coming up against heavy turbulence in the objects detected. An estimate of the precipitation gradient in a given part of the detected storm zone or cloud is yet possible from the width of luminant edging around a dead spot in the picture. The higher the gradient, i. e. the faster the rise in precipitation intensity from the edging inside the zone (or cloud), the narrower is the edging in a given part of the radar picture. Thus, narrow luminant spots in the radar picture are indicative of excessive turbulence in the particular areas of the storm zone or cloud.

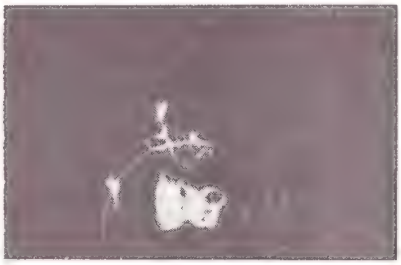


Fig. 7. Typical pictures for the radar operation in the "Контур" mode

All hydrometeorological objects resulting in such "contour" images should be bypassed at a distance of not less than 10 km. It is permissible to fly at closer distances or directly through these objects as a last resort only.

However, in the latter cases the flight should be carried out through or on the side of the widest portions of the edging around dark spots in the picture.

Do your best to avoid flying through or on the side of narrow luminant edging.

In large clouds or storm zones, several dark spots according to the number of centres with strong reflection can be observed simultaneously.

The "Groza" radar is so designed that the hydrometeorological objects whose images appear on the indicator at distances over 100 km can be just medium or large size shower-producing or thunderstorm clouds. The radar detects less turbulent formations at smaller ranges only. However, although detection of an object at distances below 100 km is indicative of probable heavy turbulence in it, dark spots in its radar picture will hardly be obtained at such considerable ranges. Therefore, all hydrometeorological objects detected by the radar at the distances over 90 or 100 km should be considered hazardous for flights irrespective of

whether there are dark spots in their images or not, keeping a watch over them. The dark spots in the images will appear gradually as these hazardous objects are approached.

The circuitry of the "Groza" radar is so designed that if no dark spots made their appearance in the images at the distances within 30 to 40 km, it is hardly probable that they will develop later on. The latter is likely, if the object concerned builds up in size intensively.

Radar Coverage for Meteorological Objects

The "Groza" radar scans space ahead of the aircraft within azimuth angles of about 100° on both sides from its longitudinal axis. Vertical size of the zone being scanned and its position with respect to the horizontal plane passing through the aircraft centre of gravity depend upon the radar version and setting of its "Наклон" control.

Most versions of the radar operated for scanning hydrometeorological objects radiate radio waves in the form of a narrow beam at a vertex angle from 3 to 4° depending upon the type of the aircraft. The beam is shown schematically in Fig. 8.

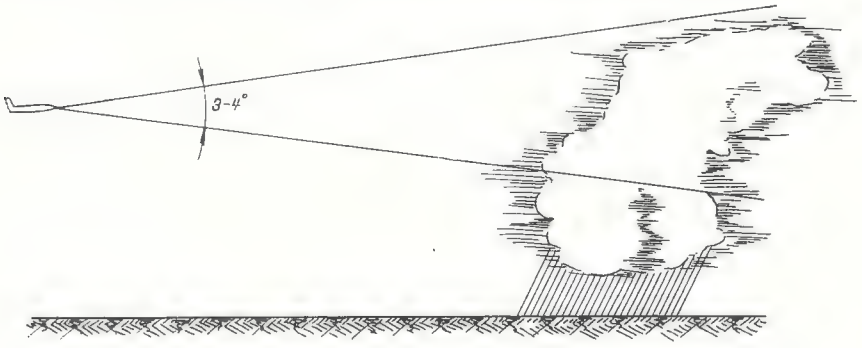


Fig. 8. Beam shape with the antenna located in the nose dome

Thus, when operating in the "Метео" or "Контур" modes, the radar scans an air space layer whose height depends upon distance and the aircraft type.

For all aircraft where the antenna is located in the nose dome, with the exception of small planes used by local air lines, this height is approximately 52 metres per every kilometre of range.

For small aircraft of local air lines with the antenna in the nose dome, this height is 70 metres per kilometre of range.

Total height of the air layer scanned at various ranges from the radar is given in Table 2.

Table 2

APPROXIMATE HEIGHT OF AIR LAYER SCANNED BY THE RADAR

Distance from radar, km	Height of Zone to be Scanned, m	
	for large and medium aircraft TU-144, TU-154, TU-134A, IL-62, IL-18, AN-24	for aircraft used by local air lines YaK-40
10	520	710
30	1 600	2 100
50	2 600	3 500
100	5 200	7 000
200	10 400	14 000

When the "Наклон" control is set to zero, the middle of this zone roughly coincides with the horizontal plane passing through the aircraft centre of gravity.

For the aircraft where the radar antenna is mounted under the fuselage (such as TU-104, TU-124, TU-134, AN-10, etc.), the zone

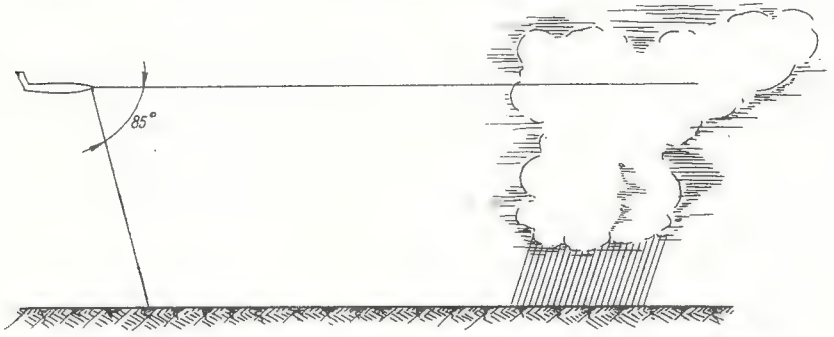


Fig. 9. Beam shape with the antenna located under the fuselage

of coverage differs considerably from that described above. Although the radar beam in this case is 3° wide in the horizontal plane, its width in the vertical plane is much greater. Fg. 9 shows the form of the beam in the vertical plane. Therefore, the "Groza" radar with the antenna located under the aircraft fuselage scans, when operating in any mode, the entire air space ranging from roughly, the horizontal plane passing through the aircraft centre of gravity to the angles within 80 to 85° down including the earth surface.

Using the Radar for Detection of Meteorological Formations

When the "Groza" radar operates, radio waves radiated by it are reflected from clouds resulting in their radar images. Capability of a cloud to reflect radio waves depends upon the size of water drops in it. The clouds containing just small drops are not hazardous for flights and do not give echoes sufficient for their detection on the indicator, i. e. those falling into top, medium and bottom cloud sheets.

Unlike them, vertical development clouds such as thick heap, heap rainy and thunderstorm clouds which consist of rather large drops result in fairly strong returning echoes making it possible to observe the clouds on the indicator at considerable ranges depending upon the size of each cloud and the stage of its development. In most cases these cloud formations involving marked turbulence are hazardous for flights.

If considerable areas ahead of the aircraft abound in precipitation such as rain, the radar free space range for hazardous clouds decreases and, what is more, interference glow from such rain not hazardous for flights can appear on the indicator screen. The atmospheric precipitation is composed of water drops of different size depending upon the intensity falling from a cloud on the earth. Any water drops on the way of radio waves radiated by the radar partially absorb radiation and partly result in returning echoes. This is why the radar free space range for hazardous clouds located inside low turbulence areas with precipitation decreases. By way of illustration we consider a heap rainy cloud detectable in clear weather at 150 km. If there is rain falling out at 4 mm/hr (moderate rain) and extending at 40 km between the aircraft and the cloud, the latter will be detected at 125 km.

Snow which is known to have lower liquid water content does not generally result in echoes visible by the radar over the whole span of ranges, although appearance of a more actively reflecting layer is possible right under the zero isotherm. Snow flakes in this layer do not melt and the rate of precipitation from it is small which results in a heavier water content of the layer. However, because of its small thickness (150÷300 m), detection of such a layer by the radar even at small ranges is hardly probable.

Above the zero isotherm snow crystals give weak echoes not visible by the radar, but below it they melt, forming small drops whose rate of precipitation is relatively high and their concentration is thus insufficient for setting up a visible signal.

Hail particulary when it has melted a little can result in very strong echoes. However, due to very high precipitation rates of any kind of hail, the echoes set up by it are in most cases not de-

tected by the radar. Hail precipitation is believed to occur, as a rule, from the areas bordering with shower or thunderstorm zones, but not from the zones proper. In this case, a projection whose shape resembles a stretched or bent finger can develop on the edge of the radar zone image. Therefore, in all cases when edges of the radar image of a hydrometeorological object grow up suddenly and rapidly, **the crew would do better to bypass such an area because hail precipitation is likely to occur in it.**

No matter how intensive whirlwinds and dust storms might be, they are detected by the radar at ranges adequate to avoid the dangerous zones.

Discriminating the Radar Images of Meteorological Formations and Ground Objects

In flight operation of the "Groza" radar with the antenna located in the aircraft nose dome, consideration must be given to the fact that at certain flight altitudes and tilt angles of the antenna beam the latter will cross the earth surface, resulting in echoes from ground objects and the earth surface proper. These echoes can be mistaken by the crew for cloud or thunderstorm echoes. To eliminate these interference echoes when flying over even ground, it is enough to raise the radar beam up to a value equal to that indicated in Fig. 10. Thunderstorm echoes do not disappear at such tilt angles and thus discrimination can be accomplished.

When flying over mountainous areas, echoes from mountain peaks can remain on the indicator at the aforesaid and even greater angles of the beam tilt. This is generally the case at small and medium ranges when the flight plane is below the level of individual mountain peaks. In such cases discrimination of echoes is not accomplished through the beam raising and the areas resulting in such echoes should be bypassed, no analysis of their nature being necessary.

At relatively large distances to mountains (80 km and more) echoes from them can be eliminated using the method described at the beginning of this paragraph. The angle of tilt required can also be taken from Fig. 10 provided that the flight altitude is regarded to be that above mountain peaks.

If the radar antenna is located under the aircraft fuselage, echoes from ground surface can partly remain even at large angles of the beam tilt. This occurs when flying at the altitudes

much less than those generally accepted for a particular type of aircraft. Nevertheless, at operational altitudes and with the antenna beam raised, echoes from ground surface disappear, although at the angles slightly larger than those indicated in Fig. 10.

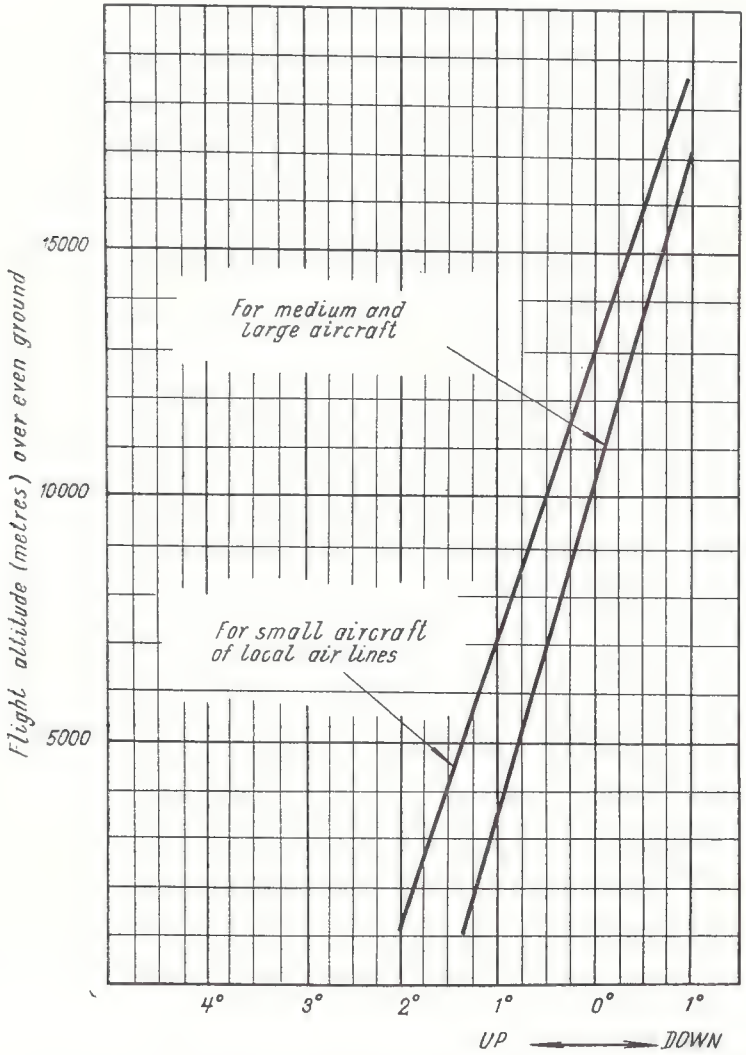


Fig. 10. Minimum angle of the antenna tilt for elimination of ground echo

Should an attempt to eliminate echoes from ground surface by elevating the radar beam fail, discrimination of echoes can be accomplished to some extent through an analysis sometimes enabling to judge their nature with an assurance. Radar images of cloud formations can be discriminated from other images by their larger size unusual even for those of major industrial centres, irregular shape, higher brightness over the whole area as well as somewhat blurred edges (see "B", Fig. 5). However, there can be cases sometimes, when the screen areas taken by these images are small, and the shape of markers is nearly oval or circular, the borders of the latter being defined rather sharply (see "A", Fig. 5). This generally occurs when observing particularly heavy thunderstorms, showers or whirlwinds.

Right behind the echoes from hydrometeorological objects specific "radar shadows" confirming their meteorological nature can be observed, if there is any assurance, of course, that within the sector under scanning there are no mountain masses which give similar "shadows".

There are no other practicable methods for identifying radar images of hydrometeorological objects, but on having gained sufficient experience the radar operators identify them unmistakably.

10. OPERATING THE RADAR FOR EARTH SURFACE SCANNING

Radar Operating Procedure for the "Земля" Mode

The "Groza" radar can scan the earth surface within the azimuth sector of 100° on both sides of the aircraft longitudinal axis. In this mode the radar antenna beam for any type of aircraft takes a shape making it possible to scan the earth surface at all ranges from minimum to the maximum one.

The possibility of using the airborne radar to obtain a "radar map" of the terrain ahead of the aircraft is based on the fact that vacant ground sites (forests, open spaces with grass lot or no such lot and so on), localities and engineering structures give returning echoes of radio waves of different intensity sufficient for gating the indicator screen. In so doing, towns (particularly medium and large cities) result in fairly strong echoes received by the radar at very large ranges within 150 to 400 km and observed on the indicator as bright spots. Echoes from vacant ground sites give continuous (but less intensive) gating of the indicator up to 100÷180 km.

In contrast, water surfaces reflect most radio waves incident upon them in a regular way, that is, aside from the radar, and,

for practical purposes, produce no gating of the screen. Radar detection of large and medium rivers and basins visible clearly against general gating from vacant ground sites in the form of black spots is based on this principle.

Typical radar pictures of the earth surface are presented in Figs 11 and 12.

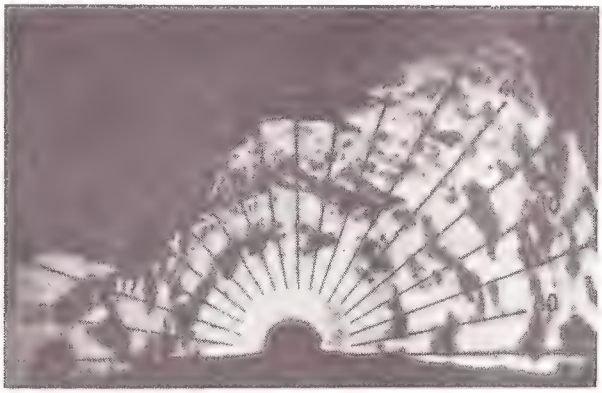


Fig. 11. Typical radar picture of earth surface

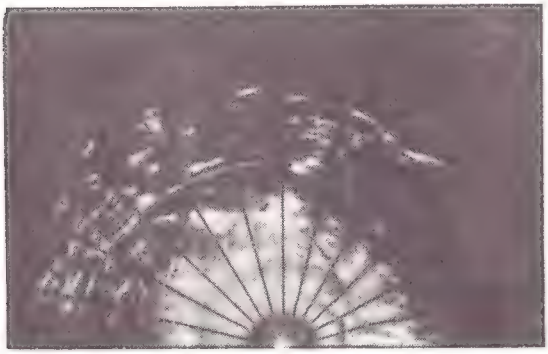


Fig. 12. Typical radar picture of earth surface

The radar operating procedure for earth surface scanning should be as follows:

— turn the mode switch over to the "Земля" position;

— turn the sweep duration switch over to the position "250";

— using the "Наклон" control, tilt the radar beam down till an image of the earth surface is visible on the screen. **When a continuous picture of vacant ground sites free from dead spots,**

with sharp gating of the screen at maximum ranges is available on the indicator, stop tilting at once.

With excessive tilting of the beam, the scanning range for vacant ground sites as well as medium and large localities decreases, while with insufficient tilting large-size dark spots develop in the images of vacant ground sites (Fig. 13). Use a chart

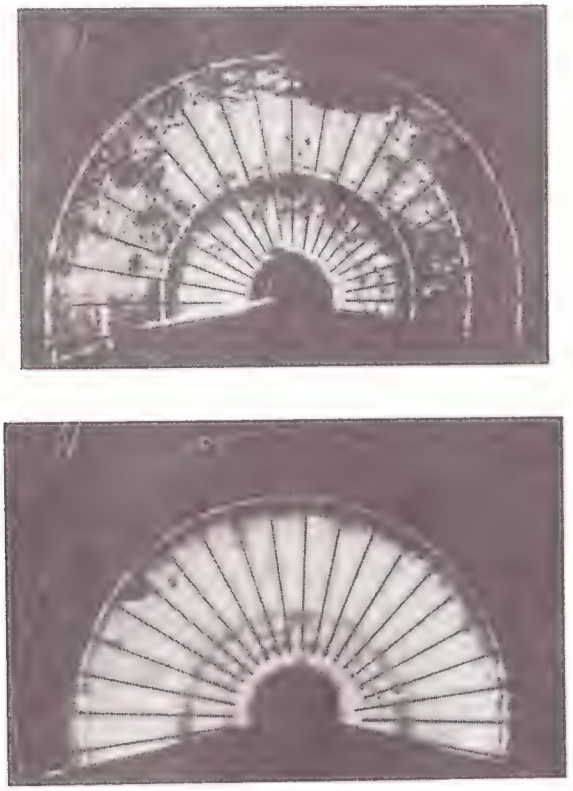


Fig. 13. Approximate shape of radar pictures for operation in the "Земля" mode:
a — with inadequate tilt of the antenna beam; *b* — with excessive tilt of the antenna beam

(Fig. 14) for approximate orientation as to what angles of the beam tilting assure optimum observation of the earth surface;

— if necessary, set a required brightness of the picture and range rings using the "Яркость" and "Метки" controls, making sure to avoid intensive gating which would make the whole screen

equally bright. Appearance of such gating would testify to the fact that the possibility of further brightness control of radar has come to an end.

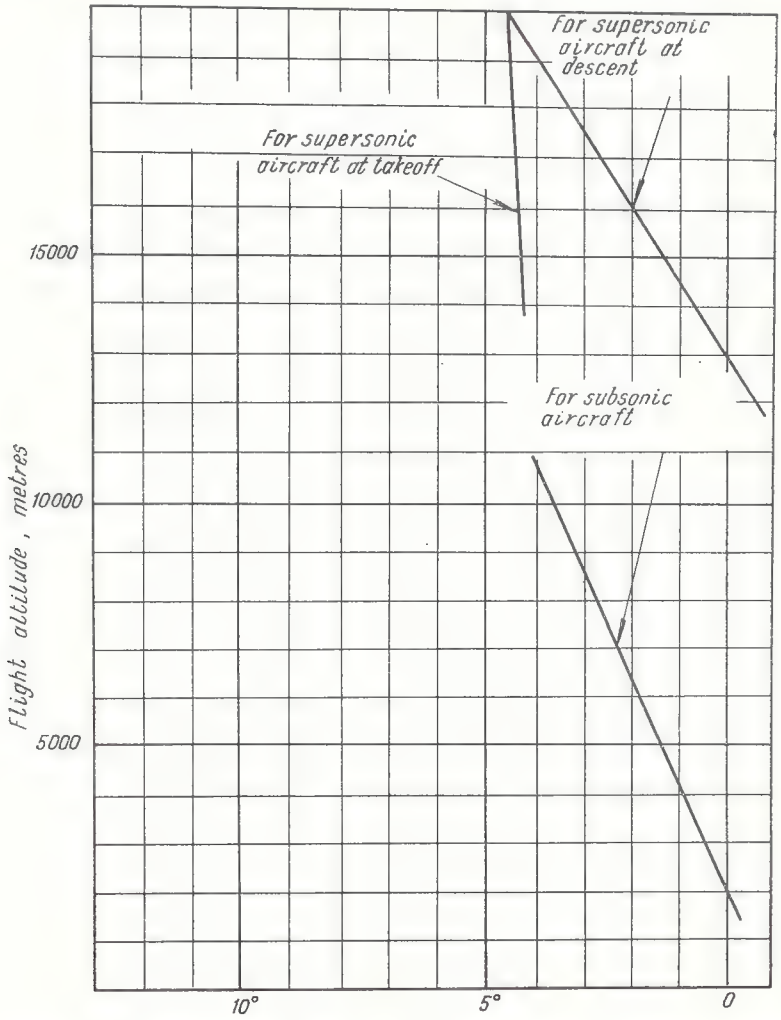


Fig. 14. An approximate angle of the antenna tilt for earth surface scanning

When operating in the "Земля" mode the "Контраст" control can be set to any position, but it would be sound practice to turn it over to its extreme left (counter-clockwise) position right after changing the mode switch to the "Земля" position;

— set the sweep duration switch to a position optimum for scanning the objects of interest for the crew (radar display scale).

Having switched on the "375" sweep on TU-144 aircraft, tilt the antenna beam through 2 to 2.5° more from the position set before. Having changed over to other sweeps, reset the "Наклон" control to its former position.

It is not advisable to use the sweeps duration of which is less than six times the altitude;

— obtain optimum contrast of the objects of interest against total background of the earth surface using the "Контраст" control.

The possibility of the contrast increase in the "Groza" radar is based on gradual elimination of echoes from larger and larger man-made objects (such as towns, etc.) in the radar picture and equalizing simultaneously the gating brilliance from vacant ground sites more and more intensively. Different parts of ground (i. e. sand, arable land, forest, meadows and so on) vary in their reflection of radio waves. Therefore, the radar picture of vacant ground sites comprises a lot of portions featuring different brilliance which reduces image contrast range for water objects against the aforesaid background and results in blurred edges of the images.

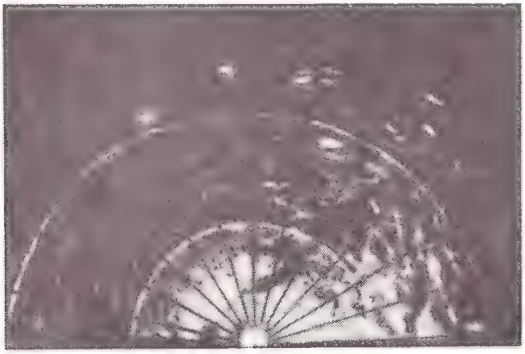


Fig. 15. An example of the earth surface display picture with the "Контраст" control in its extreme left position

Small localities, accidents of the ground, as well as individual man-made structures and objects featuring good reflection most of which are hard or impossible to identify also result in many flare spots on the screen, distracting the operator's attention and masking identifiable objects. All these disadvantages of the radar

picture of ground surface are eliminated to some extent with the aid of the "Контраст" control.

If the "Контраст" control is in its extreme left (counter-clockwise) position, the radar picture incorporates echoes from all objects — both identifiable and unidentifiable.

Typical radar pictures of the earth surfaces with the "Контраст" control fully out and in are presented in Figs 15 and 16.

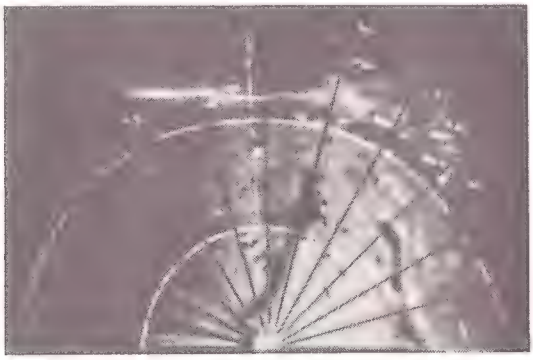


Fig. 16. An example of the earth surface picture with the "Контраст" control in a position optimum for water surface scanning

Deciphering the Earth Surface Radar Picture. Distortions Developed in Scanning

Even relatively inexperienced operators, as a rule, identify images of various water objects, when operating in the "Земля" mode, without difficulty, because for all practical purposes, they give no returning echoes of radio waves and are visible clearly among ground echoes in the form of dark spots. However, the nature and configuration of the shore line in the radar images can differ from those shown on a geographical map due to the distinctive characteristics of reflection of radio waves from various parts of coastal land. Thus, a marsh-ridden side can result in a less distinct image with a lower brightness, dead spots and depths not to be found on the map.

A mountainous shore line generally results in sharp and dark dead spots located right behind brighter spots in the radar picture as well as in broken dark strips that run deep in the shore line (Fig. 17). These dead spots and breakdowns are "radar shadows" formed behind mountains or various accidents of the ground.

The size of radar images of water objects is always slightly reduced, small and medium rivers and lakes thus being not detectable on the indicator. As the flight altitude and observation range increase, these non-detectable objects will grow in size because the radar beam is sufficiently wide and only a small part of it is crossed in the aforesaid cases by a river or a lake, the

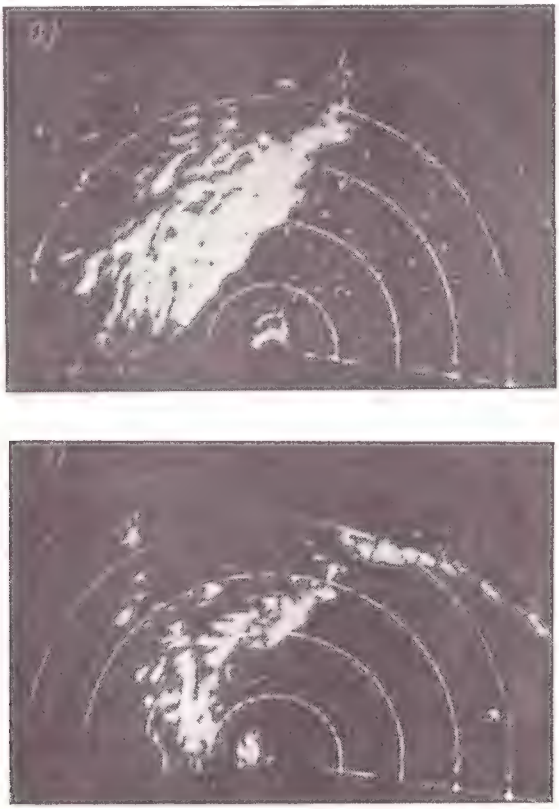


Fig. 17. Radar pictures:

a — mountainous and flat ground sites; *b* — mountainous sea shore line

rest of the beam radiating over the shores and resulting in almost as strong returning echoes of radio waves as in the case of absence of a river or lake within the beam.

If there are no water objects within the scanning zone, deciphering of radar images and identification of individual objects is more complicated and calls for a much greater experience from

the operator. Echoes from medium and large towns as well as from mountain formations are relatively easy to identify, but identification of other kinds of objects involves many difficulties and thus all possible experience should be gained continuously in operating the radar. The personnel should have a clear-cut understanding of basic principles underlying the formation and obtaining of the radar picture of the earth surface.

In doing so, it should be kept in mind that, unlike water objects, all other objects give images extended in azimuth because even a "point" reflecting object (such as a ship) produces returning echoes of radio waves during the whole period it remains within the radar beam travelling in azimuth. In this respect, its image on the indicator takes the form of an arc, but is not dot-shaped as could be expected.

As noted above, when flying over mountainous areas, "radar shadows" observed on radar pictures can be mistaken by the radar operator for images of water objects (Fig. 18). To avoid this, when approaching mountainous areas, compare the radar picture with the map at regular intervals. This step is also very useful when flying over any areas of the earth surface because it facilitates identification of images to a great extent and is beneficial for gaining experience.

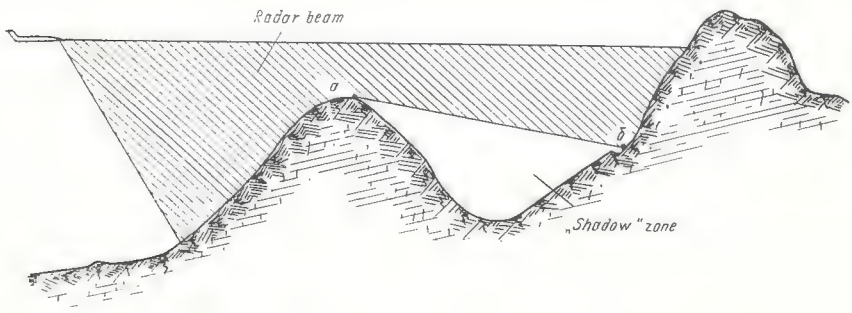


Fig. 18. Formation of radar "shadow" behind a mountain peak

Distances to various objects determined with the aid of the radar indicator are slant ranges, but not those over the earth surface used for charting geographical maps. As a result, the radar picture is always slightly different from that of the same terrain on a map, that is, certain distortions are inherent in radar images.

The difference between slant and horizontal ranges is most appreciable when scanning objects at short range. As to the distances that are more than six times over the flight altitude, this difference, for practical purposes, can be disregarded. Specifically, the objects located directly under the aircraft are observed on the radar indicator at distances equal to the flight altitude. Image distortions in the near-by zone increase with the flight altitude, the zone of marked distortion becoming wider.

The nature of the distortions described above is illustrated in Fig. 19 where a conventional representation of a shore making up a straight line is given for a sweep duration equal to 30 km and the flight altitude of 8000 metres.

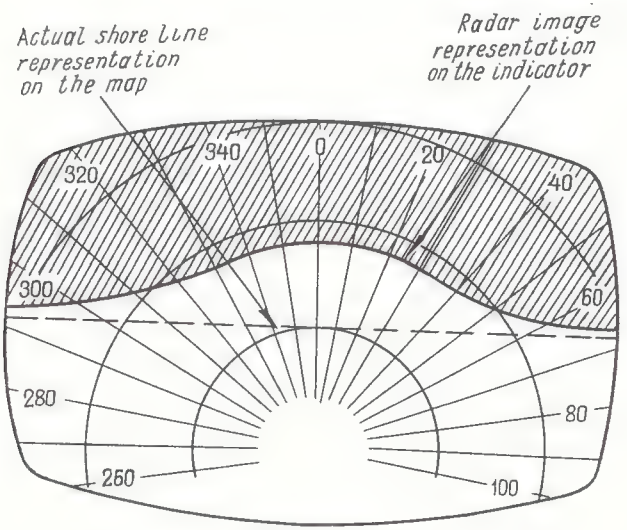


Fig. 19. Image distortion in the "Земля" mode

As will be seen from Fig. 19, the shore line image is distorted. However, all ranges measured with the aid of the range indicator are true ones and it is only the shape of an object (i. e. a ground site) which is distorted.

Approximate charts for conversion of slant range measured by the radar into that over the earth surface are presented in Fig. 20.

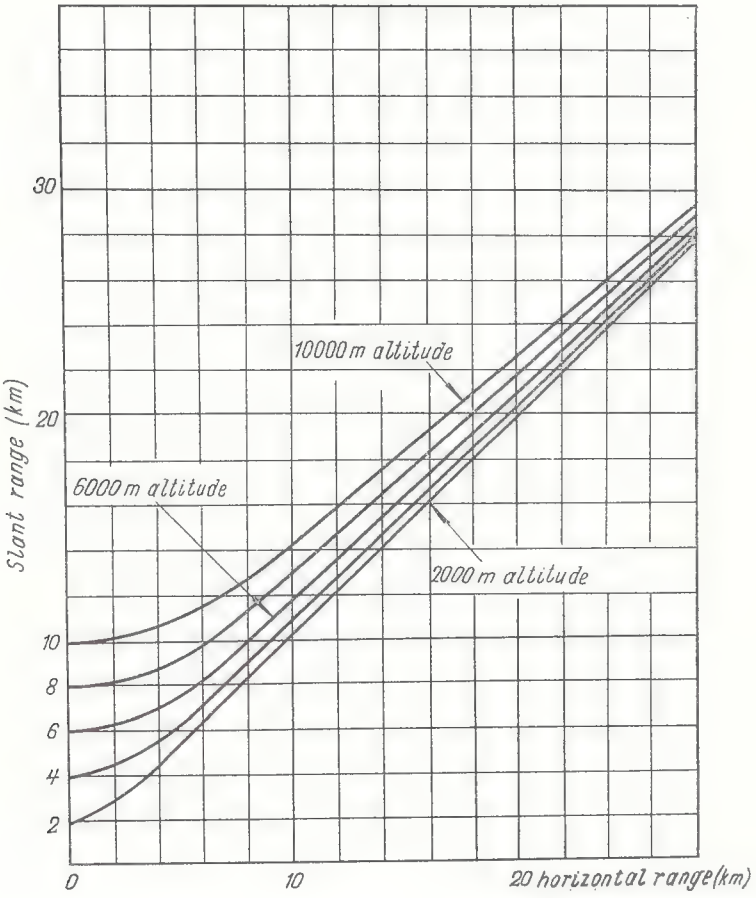


Fig. 20. Chart for conversion of slant range into earth surface range at various flight altitudes

11. OPERATING THE RADAR TO MEASURE THE AIRCRAFT DRIFT ANGLE

When operating in the "Снос" mode, the "Groza" radar measures the aircraft drift angle by the "stopped antenna" method which does not involve any radar ground check points. **Be sure to change over** the radar to this mode from the "Земля" mode on having obtained a radar picture of the earth surface on the indicator screen in the latter mode.

The radar operating procedure for measuring the drift angle should be as follows:

— set the mode switch to the "Снос" position;

— set the sweep duration switch to position "50" when flying at altitudes below 10 000 metres and to "125" — at higher altitudes.

Automatic azimuth travel of the scanning trace on the indicator should cease several seconds after the "Снос" mode is switched on, the line stopping on the screen in an arbitrary position (in the roll mode subsequent arbitrary azimuth travel of the scanning trace is possible);

— push the main indicator key marked " ⩚ " to shift the scanning trace over to that azimuth sector of the screen where the aircraft true track line is expected to be. In so doing, the rate of travel of the scanning trace can be adjusted using the "Контраст" control. If the direction of the scanning trace travel is opposite to the one required, when pressing one of the keys marked " ⩚ ", release one and push the other.

The "Контраст" control enables in a number of cases to decrease the rate of the scanning trace travel to zero. Therefore, if the line does not shift after pushing either key, turn this control over before the travel begins.

If no assumptions can be made as to the position of the aircraft true track line, shift the scanning trace up to the nearest azimuth mark corresponding to an angle of 30° or 330°;

— when approaching an assumed position of the true track line or the above mark, decrease the scanning trace rate of travel, using the "Контраст" control, to a minimum. If so, stop the trace travel by releasing the key;

— rapidly pressing the keys " ⩚ " shift the scanning trace first to one and then to the other side within the ±15° sector continuously watching variations in the glow of the scanning trace.

As the scanning trace approaches the actual position of the aircraft true track line, the scanning trace or its individual sections begin flickering first at a very high, then at a constantly decreasing frequency. The lowest frequency of flickering is observed when the scanning trace matches the actual position of the aircraft true track line.

When the scanning trace passed through the true track line position, the flickering frequency begins to increase and then flickering disappears altogether. Inasmuch as flickering develops

and varies within rather a small azimuth sector and does not occur on all other azimuths, shift the scanning trace over not more than 1 or 2° intervals or continuously at a low rate. If the scanning trace travels rapidly, the operator may fail to see the flickering sweep trace sector.

For a higher precision in determining the actual position of the aircraft true track line, it would be sound practice to obtain the minimum flickering frequency within those (top) parts of the scanning trace that are most distant from the sweep origin.

The value and sign of the drift angle should be determined on the indicator azimuth scale after the scanning trace stopped in a position characterized by the lowest flickering frequency.

When measuring the drift angle, do not set the picture for excessive brightness which makes the whole scanning trace uniformly bright, the drift angle measurement thus becoming impossible.

When flying over sea surface at a large distance from shore line, the radar is generally not capable of measuring the drift angle, but the measurement may become possible in heavy seas;

— having completed the measuring procedure, reset the mode switch to the "Метео" or "Земля" positions as required by flight conditions.

12. OPERATING THE RADAR FOR CORRECTION OF THE AIRBORNE NAVIGATION COMPUTER

If a civil aircraft is furnished with a navigation computer, the "Groza" radar makes it possible to correct present position data of the aircraft reckoned by the computer. To this end, use is made of a ground object which has known coordinates, is as small in size as possible and is easy to observe and identify on the radar indicator.

With its coordinates introduced in the navigation computer operating in a special mode, the computer determines the slant range and course angle of the object expected at a given instant. The computer transmits then the information obtained to the radar where it is plotted on the indicator screen in the form of a luminous ring for the range to be expected and a radial line for the course angle to be expected. The radar image of the ground object chosen for correction should be located at a point where the lines intersect, as reckoned by the airborne navigation computer. Since the computer reckons the present position data with an error, no such coincidence occurs in practice and, to have it accomplished, the coordinates determined by the computer should be altered.

The aircraft present position data at which the coincidence was accomplished can be regarded as true coordinates and used in the computer (instead of those reckoned before) for all subsequent calculations till the next correction is necessary, the procedure described above being the principle of the radar correction.

As is evident from the aforesaid, in the navigation computer correction the radar is but a coincidence indicator used to determine the instant when the cross lines are superimposed on the image of the object concerned. In this case the cross lines are controlled and the modes of operation of the airborne equipment set from either panel of the computer (the set of the aircraft navigating and piloting equipment), but no controls of the "Groza" radar are operated.

In view of this as well as because of substantial differences in the design of airborne computers, the correction procedure is set forth in the airborne computer (set of navigating and piloting equipment) operating instructions.

13. EMERGENCY SWITCHING OF RADAR

For disconnection of some components within the radar itself or its conjugate parts that might fail as well as for connection of standby components instead of faulty ones, the "Groza" radar incorporates a number of special switches, viz.:

— the switch for disconnection of the aircraft gyro vertical from the radar, if the former fails — "Резерв. стаб." ("Reserve stab.");

— the switch for disconnection of the faulty radar transceiver and connection of the standby one in the radar delivery sets comprising two transceivers — "Резерв. перед." ("Reserve transcr.").

For emergency switching, proceed as follows.

Faulty Aircraft Gyro Vertical. If the crew have found out for sure, when flying, that the aircraft gyro vertical to which the radar is connected had failed:

— change the radar over to the earth surface scanning mode as specified in para 10 of these Instructions;

— change the "Резерв. стаб." switch from "Откл." to its top position;

— set the "Наклон" control for an optimum picture of the earth surface in a horizontal flight free from banking.

If the gyro stabilization system supposedly failed, but it is not known with assurance whether the aircraft gyro vertical or the radar stabilization unit got faulty, it is necessary to:

— change the radar over to the earth surface scanning duty as set forth in para 10 of these Instructions;

— make certain that the system is inoperative by watching the radar indicator image and using the criteria specified in Chapter 4 of these Instructions. If there are no indications of a faulty condition, roll the system to the left and right in turn through an angle of 10°;

— change the "Резерв. стаб." switch over from "Откл." to its top position, if the radar image confirms the inoperable condition of the gyro stabilization system;

— set the "Наклон" control for an optimum image of the earth surface at zero azimuth with no banking. Make sure that there are no large dead spots in the radar picture at other azimuth angles.

If there are dead spots in the picture at some azimuths after change-over of the "Резерв. стаб." switch, the radar stabilization system is faulty.

In this case the emergency switching described above is ineffective and the radar should be cut out, if the indicator picture quality is very poor.

Faulty Transceiver. If the radar picture disappears during the flight and the "Наклон" and "Частота" controls do not enable to restore it or when no picture is obtained in the check-up for operable condition in the "Метео" mode, the following procedure should be carried out in the reserve set:

— change the mode switch over to the "Готов" position;
— change the "Частота" control to its extreme left;
— turn the sweep duration switch to positions:
"30" at flight altitudes below 3000 metres,
"50" at flight altitudes from 3000 to 5000 metres,
"125" at flight altitudes from 5000 to 12 000 metres,
"250" at flight altitudes over 12 000 metres;
— change the "Наклон" control over to a position of the radar beam tilted down through 7°;
— change the "Резерв. перед." switch over from "Откл." to its top position;
— turn the mode switch over to the "Земля" position;
— rotate the "Частота" control clockwise so as to obtain a picture on the radar indicator.

When adjusting with the aid of the "Частота" control, be sure to comply with the requirements set forth above in para 7.

Chapter 4. KEEPING THE RECORD OF THE RADAR FAULTS AND TROUBLES

Should a trouble or fault occur in the radar during the flight, a detailed description of fault indications and a record of operating and control procedures carried out by the crew after trouble shooting are indispensable for ground maintenance service. This information enables to detect the cause of fault (trouble) quickly and repair the equipment in a brief space of time which is particularly important because of a high rate of flying.

By contrast to this, such entries in the flight log book as "faulty radar", "no radar picture", "no sweep", etc. unfortunately most frequently met with are practically useless in trouble shooting and repairs.

The "Groza" radar is a complex radio electronic device and thus no single procedure for inspecting it by the crew can be recommended, should a trouble or fault occur. However, presented below is a list of questions drawn up by the radar makers. If full answers to these questions are available, they might be very useful for the ground repairmen:

1) When and how long after switching on the trouble (fault) occurred (was detected)?

2) What was observed by the crew when detecting the fault (trouble)?

3) In what mode did the radar operate when the trouble (fault) occurred (was detected)? How did the radar operate before the fault (trouble) occurred?

4) Does the radar operate in other modes after the fault (trouble) detection? How, if it does?

5) If luminous range rings disappear, jitter or vary in quantity during the radar operation at some sweep, do similar phenomena occur at all other sweeps?

6) If, with the radar set comprising two transceivers, the fault (trouble) occurs in one indicator, does in occur in the other?

7) If there is a dead spot in the earth surface radar picture, in what part (parts) of the screen is it located and what is it shaped like? In what flight modes does it occur?

8) What are the arrangements made by the crew to clear a fault (trouble) and what are the results of these arrangements?

There is no fixed form for an entry on a fault (trouble). Presented below are several examples of properly worded descriptions of faults.

Example 1. At 10.30, twenty minutes after switching on, heavy jittering of range rings occurs at sweep "250", operation at all other sweeps being normal. Before and at the moment the trouble was detected, the radar operated in the "Земля" mode. After the trouble occurred, operation in other modes at sweep "250" is neither possible. The trouble is noted in both indicators.

The radar was not cut out in flight and not used at other sweeps. The crew made no arrangements for clearing the trouble in flight.

Example 2. At 12.45, five minutes after switching the radar on, no picture both in left and right parts of the screen, when changing the radar over from "Готов" to "Земля" modes, while in the medium sector the picture is normal. No maneuvering was made while flying. The trouble was observed in both indicators, at all sweeps and in all modes of operation. Disconnection of the aircraft gyro vertical was ineffective. Radar then was cut out and not used in flight any longer.

Table 3

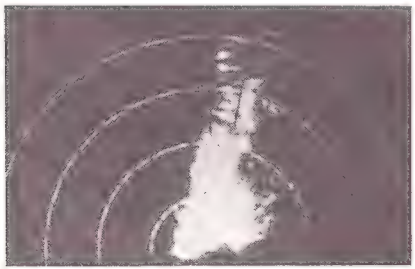
ELEMENTARY TROUBLES LIKELY TO OCCUR IN THE RADAR OPERATION AND THEIR IN-FLIGHT REMEDIES

Trouble	Cause	Remedy
With the radar changed over from "Готов" to some other mode, range rings on the indicator cannot be obtained using radar controls	Power is not supplied to the radar at all or in part	Make sure that switches and network protectors on the aircraft power supply switchboard and the navigating and piloting equipment panel (if any) are cut in. If the supply indicating lamp in the main indicator unit lights up the radar power supply is on. Cut in off duty or disconnected switches or network protectors
	Transceiver safety fuse failed	See that the red and white disc in the transceiver operating time meter dial bottom rotates. If it does not, replace the left-hand fuse in the transceiver front panel. Should the disc rotate with no range rings observed, replace the right-hand fuse
	Indicator (either one) failed	Make sure that there are no rings at all sweeps. If the radar set incorporates the second (additional) indicator and it is possible to obtain range rings on either of them, use the second one for observation. Replace the faulty indicator after landing
The radar picture cannot be obtained using the "Наклон" and "Частота" controls	Transceiver failed	Using the second (additional) transceiver, cut it in through the "Резерв. перед." switch, complying with the requirements set forth in para 13

Trouble	Cause	Remedy
The radar picture available before disappeared and cannot be restored using "Наклон" and "Контраст" controls	With the aircraft flying over a continuous stretch of water, no ground areas are within the radar scanning zone at distances above 200 km	Proceeding from the orientation carried out before, make sure that there is a continuous stretch of water ahead of the aircraft. No picture in this case is **normal** and thus is not indicative of the radar failure
The shape of range rings differs from circular one or the scanning trace length is substantially reduced over all or some parts of the screen	The main indicator failed	Operate the radar, if possible, till the aircraft landing. Replace the main indicator after landing
Continuous and uniformly bright gating over the whole area of the indicator screen, against which the radar picture is poorly visible	Excessive brightness of the picture	Rotating the "Яркость" control to the left, reduce brightness to an acceptable level or eliminate continuous gating, making sure that brightness of objects of interest for the operator is not below the level permissible
	Wrong setting of the "Уст. яркости" control of the indicator (indicators). In this case the sweep flyback should be seen on the screen in the form of a triangle located more often opposite the sweep origin	Switch the radar over to the "Снос" duty. Turn the "Яркость" control to the left until rest. If gating does not disappear completely in doing so, rotate the "Уст. яркости" control slowly until it does, engaging a screw driver in a slit provided in a special hole in the indicator top cover. Stop the rotation as soon as gating disappears
With the indicator screen and range rings very bright, the display is heavily defocussed (blurred) and there are haloes around the brightest areas	Excessive picture brilliance	Rotating the "Яркость" control to the left, decrease brightness to an acceptable level

Trouble	Cause	Remedy
	Transceiver failed	If the "Яркость" control fails to reduce excessive brightness observed on both indicators, switch on the second (duplicating) transceiver (if any), proceeding as specified in para 13
	Indicator failed	With the radar set incorporating the second (additional) indicator and but one screen glowing bright, continue operating the radar in case of emergency. Replace the abnormally bright indicator after the aircraft landing
Observation range for the radar picture of vacant ground sites as well as large and medium localities is generally less than that to be obtained (as specified in Table 1 of these Instructions)	Wrong setting of the "Частота" control due to considerable variations of some parameters of the radar	Switching the radar over to the "Готов" mode and returning the "Частота" control to its extreme left position, use this control to obtain the radar picture of ground surface again. If this results in reduced observation ranges once more, replace the transceiver after the aircraft landing. Should another (duplicating) transceiver be available on board the aircraft, switch it on, proceeding as specified in para 13
When flying at night and setting a low level of the screen brightness, images of vacant lots and towns cannot be obtained simultaneously on either indicator	Wrong adjustment of the indicator "Уст. яркости" control	Change the radar over to the "Спос" duty. Setting the "Яркость" control to its extreme left position, rotate the "Уст. яркости" control so as to obtain the scanning trace on the screen. Then, rotate the latter in the opposite direction till the scanning trace disappears and stop rotating at once. Rotate the "Уст. яркости" control, engaging a screw driver in a slit provided in a special hole in the indicator top cover

Trouble	Cause	Remedy
With the mode switch changed over to the "Снос" position, the scanning trace keeps moving on the indicator	The radar control and stabilization unit failed	Replace the unit after the aircraft landing. Do not operate under the "Снос" conditions in flight, measuring the drift angle in the "Земля" mode by motion of check points
With the "⋈" key pressed in the "Снос" duty, the scanning trace does not run over the indicator screen	Wrong setting of the main indicator "Контраст" control	Rotating the main indicator "Контраст" control, set the required rate of the scanning trace travel
	The radar control and stabilization unit failed	Replace the unit after the aircraft landing. Do not operate under the "Снос" conditions in flight, measuring the drift angle in the "Земля" mode by motion of check points
With the scanning trace moved manually over the whole range of azimuth angles from 330° to 30° and the radar operating in the "Снос" mode, no flickering of the scanning trace is observed	No ground echoes	Proceeding from position finding carried out before, make sure that there is (dry) ground within the radar coverage, zone over the range corresponding to that set on the sweep duration switch. When flying over a continuous stretch of water, no measurement of the drift angle is generally done **Change over to the "Снос" duty from "Земля" conditions only, with a clear picture of the ground surface available in the latter mode**

Trouble	Cause	Remedy
	Excessive brightness of the ground surface radar picture	Change the radar over to the "Земля" duty again and reduce brightness so as to enable observing the brightest elements of the ground surface picture. Then shift the radar to the "Снос" mode
With the radar operating in the "Земля" mode, there is no picture at all or it disappears at regular intervals over the screen edges (on the left and right) or within the centre of the screen (Fig. 21)	The aircraft gyro vertical failed	Using other aircraft instruments, make sure that the gyro vertical failed. If it did, disconnect it by means of the "Резерв. стаб." switch, as set forth in para 13
	The radar control and stabilization unit failed	Using the "Резерв. стаб." switch, disconnect the aircraft gyro vertical, as set forth in para 13. If the indicator picture quality did not change in so doing, report on the failure to the ground repair men after landing. Use the radar in flight prior to landing, if necessary, bearing in mind that this will not result in a failure of other units of the radar
 Jittering or variations in number of the indicator range rings	Normal operation of the main indicator is upset	Change the sweep duration switch to position "375", then reset it back. If jittering does not disappear or the number of range rings still differs from that required, check for trouble-free operation with other sweeps. If the radar is operable at other sweeps, be sure to operate the equipment at these sweeps before landing

For Notes

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